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TYPE I PROGRESS REPORT, NO. 4

Investigation of Application of ERTS-A
Data To Integrated State Planning
In Maryland

GSFC ID:ST 352

MAY 31, 1973

Type I - Progress Report, for period ending May 31, 1973.

Title of the Investigation with ERTS-I Proposal Number: Investigation of Application of ERTS-I Data to Integrated State Planning in Maryland MMC 261

GSFC ID: ST 352

A. Objective

The objective of this project is to evaluate the utility of satellite and aircraft remotely sensed data to integrated state planning. To achieve this objective, remotely sensed data are being evaluated for their applicability to land use inventory, land capability evaluation and land use suitability in the State of Maryland. Remotely sensed data is being integrated with other data to consider its applicability in the framework of state planning objectives.

B. Summary of Work Performed

I. The accomplishment of several objectives have moved forward the efficient completion of this investigation since the last report. (Type II for period ending March 31, 1973). The following discussion summarizes these activities by task; only those items which have changed since the Type II report are included.

Task Description

A. 5. Refine Existing Inventory:

Status: Substantially completed.
See : Section D.1.

Recent studies have analyzed land use in the Deep Creek Reservoir and vicinity of Garrett County in Western Maryland using time sequential underflight imagery.

B. 2. Identify Suitability Classes:

Status: Substantially completed.

Data sources for capability and suitability classes have been identified and a digital geo-base methodology selected. Data sources are presently being collected and digitized for subsequent analysis. Completion of this task will be addressed at the time of data analysis.

B. 4. Define Guidelines for Capability:

Status: Substantially completed.

Data sources have been identified and are currently being collected for digitization.

B. 5. Define Guidelines for Suitability:

Status: Underway - No progress to report to date.

B. 6. Determine Capability from Images/Supplementary Data:

Status: Underway - No progress to report to date.

B. 7. Determine Suitability from Images/Supplementary Data:

Status: Pending - To be addressed with analysis of suitability/capability data.

C. 5. Supplement Short Range Data Storage Display for Images Interpretation:

Status: Substantially completed - Continually up-dated data display.

The location of all underflight imagery of Maryland received by EarthSat has been plotted on reproducible State base maps. To date there are 28 map sheets, updated (by addition) as imagery is received.

D. 1. Temporal Analysis of Land Use in Selected Areas:

Status: Substantially completed.

Additional efforts have included (1) the 1972 update for Land Use in the Deep Creek Reservoir vicinity (see Section D.1.); and (2) work in progress to analyze land use from ERTS and underflight imagery in selected urban and fringe localities (to be reported).

G. 1. Evaluate Remote Sensing Information - LAND USE INVENTORY

Status: Underway.

Substantial progress has been made in two areas of study: (1) the Deep Creek Reservoir vicinity; and (2) vegetation of Worcester County, discussed in Section D.1. and D.2. Additional studies are presently directed toward further analysis of the Worcester County vegetation data and selected studies in urban and urban-fringe localities. This task has been delayed in order that seasonal

variations and their subsequent effects on the environment may be analyzed and reported.

D. 4. Compare Usefulness of Satellite to Other Imagery:

Status: Underway - Substantial progress, included in Task D.1. above.

D. 6. Compare Incremental Costs/Savings vs. Common Data Sources:

Status: Underway

With each activity and task, time (cost) data are collected and reported. Summary and analysis will be included in the Type III report.

II. Previously reported was a project with the Maryland Soil Conservation Service, at the recommendation of EarthSat, to prepare a Statewide Natural Soils Group Map. This project, funded independent of NASA support monies, has been completed. The results are now being applied to the digital capability analysis of Maryland.

III. M. John Antenucci - attendance at Land Use Workshop in Boston

C. Work Schedule

To date, work progress has been completed in accordance with scheduled Tasks.

D. Progress Analysis

(1) Detailed Analysis of Deep Creek Reservoir and Vicinity.

One frame of high altitude infrared ektachrome aerial photography of the Deep Creek Reservoir and vicinity, in Garrett County, has been analyzed, and a detailed land use map of the study area has been produced. This analysis culminates a continuing effort to study and document: (a) the capability of extracting Level II land use information from ERTS underflight photography; (b) refinement of existing inventories; (c) techniques for updating land use information; (d) and temporal analyses.

Previous efforts have been restricted by problems of data quality and weather. ERTS imagery of the study area was analyzed using January 11, 1973 MSS imagery, as part of a general land use inventory of the State. This activity was reported in Type II Report for the period ending March 31, 1973. Previous underflight photography of suitable scale and format e.g. August 22, 1972, included cloud coverage over approximately 60 percent of the lake shore and surrounding area. The present photography, acquired January 26, 1973, was cloud free and proved to be more than adequate.

During recent years interest by the State planning community has focused on the Deep Creek Reservoir vicinity because of development and environmental pressures along the lakeshore, and between the reservoir and the City of Oakland to the southeast. Effective advance planning requires, among other things, accurate and current data on land use and land use change. Hence, the study area has been an important locale for demonstrating the application of ERTS and other remotely sensed data (i.e. high altitude color infrared photography) to planning community interests.

Below is a list of the most significant results of the Deep Creek Reservoir analysis; an illustrated and detailed discussion, along with the map product, are on file with the Department of State Planning. The report and map will be reviewed by local planners in Garrett County and included in subsequent NASA reports.

- The land use map, at approximately 1:125,000 scale, contains 16 categories (Level II). Two categories - "mixed" forestland, and abandoned agricultural lands previously cleared for cultivation and/or pasture--were added to this map that were not delimited in previous maps.

- More accurate boundaries were delineated in the present maps than in previous image interpretations, and smaller area units have been presented, particularly in the Oakland urban area and along the Deep Creek Reservoir shorelines.

- Although January is a period of low solar illumination angle, characteristically producing long shadows on north facing slopes and thereby obscuring some details, season generally served as an advantage. Deciduous hardwood forests were defoliated and the photographic interpretation utilized the advantage of phenological differences between hardwood and coniferous forest species. Coniferous trees appeared as bright reds; the hardwoods, in contrast, were distinguished by brownish hues of distinctly different texture and pattern from agricultural areas.

- Housing developments and infrastructure around Deep Creek Reservoir and other urban areas were not obscured by a hardwood vegetative canopy on the January photography. This enabled more accurate delineation and analysis than on previous photography examined.

- There was a light snow cover in some areas of the image. Many agricultural areas were well defined by shape and pattern with snow enhancement. It has been previously reported that similar light snow cover often enhances agricultural patterns on ERTS imagery, particularly Band 5 where there is high contrast between the white snow and dark forest lands juxtaposed upon the landscape.

- In the hardwood forests, snow cover often presented a unique "tweedy" texture not apparent in coniferous and lesser apparent in mixed forests. Snow cover was of light and limited extent such that no details of land use interest were obscured. Ice and fracture patterns were apparent on all water body surfaces, particularly Deep Creek Reservoir.

- **Garrett County** contains extensive acreages of abandoned agricultural land which has reverted to grass and brush vegetation. Precise locations were not known to the image interpreters and were found to be generally difficult to distinguish from areas appearing to be pasture. (Some areas in which cultivation has been abandoned may, in fact, be used for pasture.)
- The study area was approximately 208 square miles. Basic image interpretation required 12 hours; editing, 3 hours; cartography, 8 hours; and analysis, 6 hours.

(2) **General Vegetation Analysis of Worcester County from ERTS-1 Imagery**

Worcester County is located in the east-central portion of the Delmarva Peninsula. Outside of a few relatively small towns (e.g. Pocomoke City, Snow Hill, and Berlin) and the coastal developments in the vicinity of Ocean City, the County is predominantly a mixture of agricultural forest and wetlands landscapes. Overall, the general vegetation of Worcester County is considered representative of other areas of the Eastern Maryland coastal plain.

Both ERTS-1 imagery and underflight aerial photography have been independently analyzed and evaluated for delineating general vegetation in Worcester County. The ERTS-1 analysis included black and white images of several scales and dates, and multi-date color combinations on a preliminary basis. High resolution underflight photography was independently interpreted to provide (a) a "ground truth" map for evaluating the ERTS-1 derived vegetation map, and (b) along with ERTS, a selective, sample basis for interpreter training.

At present the only vegetation maps available to the Maryland Department of State Planning are (a) detailed species maps compiled over 25 years ago at 1:24,000 scale, and (b) 1970 General Land Use maps at 1:126,720 scale which show forestland as either light or dense crown cover (\pm 39%). The State planning community is interested in accurate and current inventories of natural resources, including forestlands, for effective environmental and general land use planning. The present analysis is a preliminary effort to demonstrate the application of ERTS-1 imagery for providing in a timely manner the level of vegetation resource data of interest to the State Planning community. The following summarizes this effort; a detailed discussion, along with maps and illustrations, are on file with the Department of State Planning. The report will be reviewed by appropriate State and regional planners and included in subsequent NASA reports.

"GROUND TRUTH"

Two dates of high altitude infrared ektachrome RC-10 photography, acquired over Worcester County by NASA on January 26 and 31, 1973, were utilized as ground truth for the ERTS-1 image analysis. The high quality of these data proved to be more than adequate. A map was produced at approximately 1:130,000 scale, indicating general vegetation by deciduous hardwoods versus coniferous categories. Image interpretation utilized winter season phenological differences to distinguish between hardwood and coniferous species. Coniferous trees appeared as hues of red on the color infrared photography; in contrast hardwoods without leaves were distinguished by brownish-green hues.

Interpretation boundaries delineated, first, forest land from other land-use types in the county, and second, within forest, deciduous hardwood or coniferous. The latter delineation utilized a binary decision rule of ≥ 51 percent tree stand by type. This decision rule was difficult

to implement in several areas of mixed stands; in such instances, the interpreter applied subjective decisions. The other significant aerial photographic problem concerned separation of hardwood trees and brush, which both appear as similar brownish-green hues; therefore interpreter decisions were based, where possible, on textural characteristics.

ERTS-1 Analysis

The analysis of ERTS-1 imagery to differentiate stands of deciduous hardwood and coniferous trees in Worcester County utilized imagery of two dates. Imagery acquired October 10, 1972, and January 26, 1973, were good quality and sufficiently separated temporally to take advantage of phenological changes for image interpretation. A general vegetation map was produced from photographic enlargements for multi-dates of ERTS-1 MSS bands 5 and 7, at 1:250,000 scale. Positive transparencies at 1:1,000,000 scale of all four MSS bands for both dates were employed when necessary to check interpretation accuracy. In addition, a preliminary analysis was performed using optically color combined and enhanced multi-date imagery. This latter analysis was directed toward a quick-look potential of this technique to aid in differentiation of forest and other land use categories in subsequent investigations.

Underflight aerial photography, described above, was used as "ground truth" and to verify category selection only. Map boundaries were interpreted directly from ERTS-1 images; tone, shape, and texture were the major factors used in the boundary delineations. Interpretation decision rules similar to the aerial photographic analysis above were applied to the ERTS-1 image analysis.

Summary of Results

- It is relatively easy to differentiate forest land from all other landscapes; deciduous versus coniferous separations are more difficult, particularly in areas of mixed stands. Consistently unique and identifiable tone/texture patterns exist for largely homogeneous tree-type stands; diversity in species composition increases discrimination difficulties.
- Boundaries in coastal areas were difficult to delineate on multi-band-multidate imagery due to variations in water penetration as well as tidal fluctuations. Also it was often difficult to differentiate coniferous vegetation from wetlands specie regimes.
- Riparian vegetation in several areas of the County rendered unique tonal signatures which did not accurately correlate with a coniferous/deciduous boundary. Further analysis is required for accurate explanation of the factor(s) responsible for this unique signature variation.

- . Preliminary comparisons of the "ground truth" map derived from aerial photography, the ERTS-1 derived map, and multi-date, multi-band color combinations indicate general agreement of the data. These broad correlations indicate that further analysis is warranted, particularly of additional multi-date and multi-band color composite enlargements. Such analysis is underway, to be reported subsequently.
- . The area of Worcester County is 589 square miles consisting of approximately 483 square miles of land and 106 square miles of water. Aerial photographic interpretation required 28 hours, map preparation and analysis 20 hours; ERTS-1 interpretation required 15 hours; map preparation and analysis 10 hours.

E. Project Reliability

The high quality of supporting data on capability suitability now being collected and digitized, and markedly superior underflight photography collected in December, 1972, and January, 1973, will ensure that a high quality, consistent evaluation base for comparison with ERTS data will be available for Maryland.

F. Adequacy of Funds

It was reported in February, 1973, that allocated funds were not adequate to cover the various issues in this contract. Additional funding was requested and documented at that time. Recently this request was approved and it is now believed that not only will the contract issues be fulfilled, but that the project will shortly have results applicable to other states.

G. Personal Changes

Dr. David S. Simonett continues as EarthSat's project director and Mr. William G. Brooner as its project manager.

H. Summary of Work Planned

- (1) Continue collection and preparation of source data for digitization in the geo-base computer analysis for capability/suitability.
- (2) Explore several electronic and optical enhancement procedures and evaluate the usefulness of these techniques for extracting land use, change, and update information from ERTS-1 imagery.
- (3) Further refine, as feasible, the analysis of vegetation and other land uses in Worcester County, a site representative of Eastern Maryland.

- (4) A variety of other relevant state and regional resource and environmental data analysis, required by state and regional planners for their development and planning activities, are under continual review and effort. These include efforts to optionally determine capability and applicability of ERTS-1 imagery along with supporting data, to identify and specify optional interpretive procedures, and determine estimates of time and cost information necessary to provide the state and regional planning community with geographic resource information.
- (5) To date, most of the efforts undertaken have utilized black and white, single band ERTS-1 imagery and black and white enlargements, with lesser emphasis on multi-band and multi-date color combinations. Future efforts, to be initiated in the next reporting period, will place greater emphasis on color products for extrapolating land use and related environmental data of interest to the State Planning Community. These will include multi-date color product analysis as well as multi-band color products. Previously, use of color composites has been purposely delayed in order to make effective advantage of seasonal, multi-date ERTS image information.